MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

EMG4076 – ELECTROMAGNETIC INTERFERENCE

(TE/RE)

21 OCTOBER 2019
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages including cover page with 4 questions only.

2. Attempt all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided.

Question 1

(a) Consider three parallel wires, two are the signal leads (lead-1 and lead-2) and the third is a common signal-return lead (lead-G). The circuit of **Figure Q1** represents the capacitive and the inductive couplings between the circuits. Consider resistive source and termination impedances only: R_{1S}, R_{1L}, R_{2S} and R_{2L}.

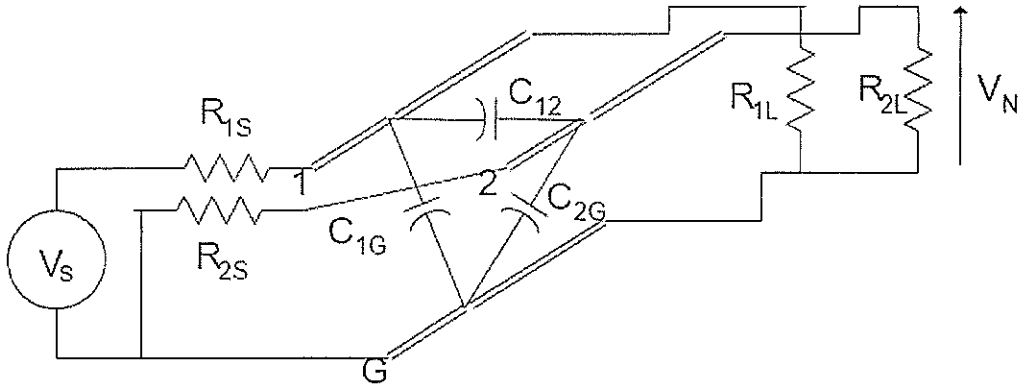

Figure Q1

(i) Draw the equivalent circuit due to inductive coupling only.

[4 marks]

(ii) By analyzing the circuit in (a)(i), derive the noise voltage, V_N due to inductive coupling.

[9 marks]

(iii) Draw the equivalent circuit if lead-2 is shielded in order to reduce inductive coupling.

[5 marks]

(b) With the aid of diagram, explain the implementation of common mode choke in reducing the noise voltage due to inductive coupling.

[7 marks]

Continued...

Question 2

(a) Partitioning of a printed circuit board (PCB) layout is necessary to reduce the interference among the components and different types of circuit on the PCB. Describe five (5) steps in PCB layout and partitioning process.

[10 marks]

(b) The circuit in **Figure Q2** represents the connection of a Class-B Power Amplifier (PA) to its signal source. Impedance Z_L represents the speaker load, while Z_1, Z_2 and Z_3 represent the impedance of interconnecting wires.

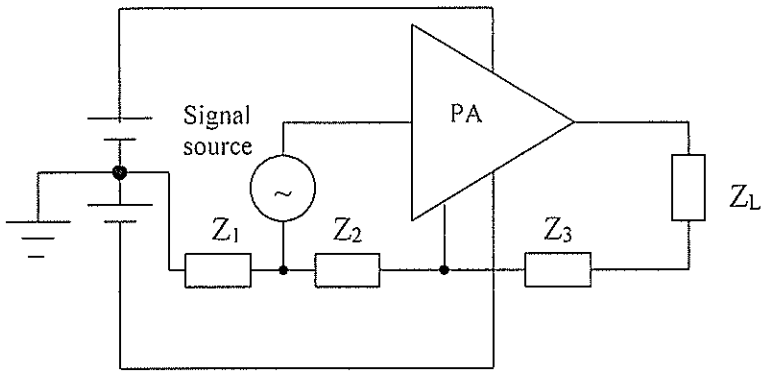

Figure Q2

(i) Explain how common impedance coupling can cause the power amplifier (PA) to oscillate.

[4 marks]

(ii) Propose a better schematic of connection to overcome the oscillation problem.

[5 marks]

(c) Explain the electrostatic discharge (ESD) in an electronic circuit. State four (4) ESD coupling mechanisms.

[6 marks]

Continued...

Question 3

(a) Signal from a source can couple to distant devices by means of radiated emission. State three (3) design techniques to minimize radiation due to:

(i) Current loop

[3 marks]

(ii) Electric dipole

[3 marks]

(b) An electronic device operating at 100MHz is to be installed in a shielded enclosure made of an annealed copper. The conductivity and relative permeability of the shield material are 5.82×10^7 S/m and 1, respectively. For a perfectly shielded enclosure, determine the following:

(i) The thickness of the shield to provide an absorption loss of 90 dB.

[3 marks]

[Hint: $\delta = \sqrt{\frac{2}{\mu\omega\sigma}}$, $\mu_0 = 4\pi \times 10^{-7}\, H/m$, $\varepsilon_0 = 8.854 \times 10^{-12}\, F/m$]

(ii) The reflection loss and the shielding effectiveness of this enclosure in dB, assuming that multiple reflection loss is negligible.

[3 marks]

[Hint: $R = 20\log(30\pi\sqrt{\frac{\sigma}{\mu\omega}})$ dB]

(iii) A stainless steel with a relative conductivity of 0.01 and relative permeability of 200 is used as the material for the shielded enclosure. By using the same thickness of annealed copper shield in (b)(i), calculate the absorption loss, reflection loss and the shielding effectiveness of this stainless steel material.

[5 marks]

(iv) Conclude your observation about the shielding effectiveness for both materials.

[2 marks]

(c) Propose three (3) treatments on the slots in cabinet shielding in order to reduce the electromagnetic interference (EMI) leakage.

[6 marks]

Continued...

Question 4

(a) Electromagnetic compatibility (EMC) regulation is very important to control the level of radiated and conducted emission. State four (4) types of EMC test defined by the European standard.

[4 marks]

(b) Sketch the setup of an automated system for radiated emission measurements. Describe the measurement procedure.

[12 marks]

(c) An antenna is connected to a spectrum analyzer using a 10 meters coaxial cable to measure the radiated emission from equipment under test (EUT). The distance between the EUT and the antenna is 3 meters. At 200MHz, the loss of the coaxial cable is 1.5 dB per meter and the antenna factor is 4dB. If the reading on the spectrum analyzer is 20dBμV,

(i) Compute the electric field strength at the antenna in dBμV/m.

[3 marks]

(ii) The EN55022 radiated emission limits are given in **Table Q4**. Compute the Class B limits in dBμV/m at 3 meter distance.

[4 marks]

Table Q4

Frequency Range (MHz)	Class A Limit at 10m (μV/m)	Class B Limit at 10m (μV/m)
30 to 230	100	32
230 to 1000	224	71

(iii) Evaluate whether the product pass or fail the EN55022 Class B radiated emission test.

[2 marks]

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